DUST CONTROL FOR RED MUD RESIDUE OPERATIONS

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Abstract

Dust from red mud tailings operations is an issue for alumina refinery operators globally. The potential for fine caustic dust particles to be whipped up by wind erosion and potentially transferred to nearby locations is a problem affecting both the safe operation of the refineries, as well as neighbouring communities and residences. As a result, effective strategies to control and mitigate dust formation and transport is an essential part of every refinery's operation.

A wide array of dust control products is available and a number have been used extensively across a broad range of mining and mineral processing applications. Recent work has assessed a number of products for their capacity to supress dust formation on the surface of drying red mud. A well-established test method under controlled conditions over a 10 week drying period was used to assess the effectiveness of a range of dust control programs. Test results are presented which show substantial reduction in the generation of dust. Potential application methods are discussed.

1. Introduction

Dust from red mud tailings operations is a particular issue of concern for alumina refinery operators globally. The potential for fine dust particles, which may contain caustic, to be whipped up by wind erosion and potentially transferred to neighbouring locations is an issue affecting both the safe operation of the refineries, as well as neighbouring communities and residences.

Many refinery operators face the continual seasonal problem of dust being generated by drying of the red mud that is deposited in tailings disposal areas. Mitigation of the transfer of this dust during the dry months of the year can be managed by various means that can include covering with mulch and/or revegetation where applicable. Another alternative, more often favoured by operators, is watering of the mud surface. Typically the dry disposal areas are watered using an extensive sprinkler system with sufficient water to wet the surface and reduce the potential for dust transportation. The watering may continue on a regular basis (as required) dependent on the prevailing weather conditions. While such regimes can be employed, they are less than ideal and involve extensive use of sometimes limited water supplies – the greatest need of water for dust control typically being in the driest season. Alternative strategies that may provide improved dust control and/or a reduction in the amount of precious water used are therefore desirable.

Nalco provides a range of dust control reagents with a variety of mechanisms that are utilized across a number of industry sectors. However, the unique nature of dust formation from the drying of red mud means that an ideal candidate for treatment of bauxite residue areas is not immediately obvious. Fortuitously, an established test method for the generation of dust from red mud has been independently developed and used [Klauber, 2010]. A hybrid method based on the original methodology was then separately developed by Nalco and while it has some obvious shortcomings, it nonetheless provides a controlled environment that allows for comparative study of treatment regimes. Consequently, using this new method, a screening program with a variety of products designed to potentially reduce the amount of dust generated was conducted.

2. Experimental

2.1 Specific Equipment Description and Set-Up

- Plastic tubs - 33 x 33 x 28 cm, 9 holes drilled in base, raised from ground using 4 spacers (1.5 cm).
- Plastic collection trays - 50 x 45 x 7 cm.
- Filter cloth – polypropylene cloth, 1 µm pore size
- Application device – 5 L Pump-Action Sprayer fitted with fan nozzle.
- Vacuum attachment - pyramid-shaped metal collection device, 18 x 18 cm base area, peak of device attaches to a vacuum cleaner hose; underside contains 4 air inlets that direct air flow in a clockwise direction (formation of 'mini-cyclone').

The test work was completed in the greenhouse facility designed by CSIRO and located at the Australian Minerals Research Centre, Waterford WA. The work was performed over the period 21st Dec 2010 – 11th March 2011 where the average maximum daily temperature was 32.9°C [Average temperature data, 2011]. Temperatures inside the greenhouse were typically 10°C warmer than outside.

The plastic tubs were lined with filter cloth, which was secured at the edges with adhesive tape, and then positioned inside the collection trays. Fresh red mud slurry, as pumped to a disposal area at an operating refinery, was collected and then mixed using an electric mixer. Samples were then poured into each tub to the brim. Liquor was pumped from the collection tray and from the mud surface periodically for the next 3 days. After one week (when the mud surface was relatively dry) the product application was commenced.

2.2 Application & Schedule

Four chemically different Nalco additives were chosen for use in the test. Together these products represented a broad range of chemistries with potentially different mechanisms operating to control dust formation. An application concentration of 1 wt-% in deionised water and an application frequency of weekly and twice weekly for a total of 10 weeks was adopted and tested in duplicate. Application volumes were 0.5 L per tub (equivalent to ~5 mm rainfall). A total of 22 tubs were used to complete the test work. Applications in duplicate were applied with individual tub locations randomized within the treatment area. The dilute solutions were prepared the day prior to application and applied evenly to the mud surface using the application device. Products used and their application schedule are detailed in Table 1.

Table 1: Application schedule for Nalco product testing.

Tub No.	Product Identifier	Application Frequency
1/12	None	N/A
2/13	Water	Weekly
3/14	Water	2 x Weekly
4/15	81620	Weekly
5/16	81620	2 x Weekly
6/17	81201	Weekly
7/18	81201	2 x Weekly
8/19	Dustbind Plus	Weekly
9/20	Dustbind Plus	2 x Weekly
10/21	6278-51-1	Weekly
11/22	6278-51-1	2 x Weekly

2.3 Dust Collection

At the end of the 10 week application period the entire surface crust from the mud in each tub was carefully removed and the underside brushed gently back into the tub to recover any dust. The number of pieces of surface crust per tub was counted. The vacuum attachment was gently pressed on the mud surface and the surface vacuumed for 2 min (Collection 1). Two distinct filtration systems inbuilt in the vacuum cleaner were used. This allowed collection of both fine and coarse dust as separate samples for each collection step. The collected dust as separate coarse and fine fractions was then weighed.

The inlet ports of the vacuum attachment were then connected to a compressed air source and the air flow was controlled by maintaining a pressure of 50 psi. This generated a 'mini cyclone' environment within the pyramidal collection unit. Again the sampling device was pressed on the mud surface and the surfaces re-vacuumed for a further 2 min (Collection 2). Collected dust samples from both coarse and fine fractions were again weighed.

3. Results & Discussion

The aim of this test work was to assess the effectiveness of a range of Nalco dust control products to supress dust formation on the surface of drying red mud. The work was designed to identify a dust control program that could be readily implemented into refineries that currently utilise existing water application systems within the disposal areas. Ideally it was envisaged that additives could be potentially applied using existing sprinkler systems (or the like) by dilution into the feed water and then sprayed onto the surface of the drying mud.

3.1 Application

All Nalco products tested were readily sprayed and applied at a concentration of 1 wt-%. Application devices, including hoses and fittings, were flushed with clean water after each use to prevent any potential blockages from dried product solutions.

3.2 Dust Collection

There was very little dust observed on the mud's crust surface after the 10 week test program, even in the untreated samples. If any dust was formed here it was assumed that the continual aqueous application in the treated samples carried the dust into cracks in the crust or over the edges of the mud pile. During a windy event in the tailings area, it is assumed that these surface crusts that are formed may be lifted and the underneath dust exposed and made available for transport. For this test work the crust was removed to measure the dust formed underneath. Figure 1 details the total amount of dust collected from each tub after both collection procedures.

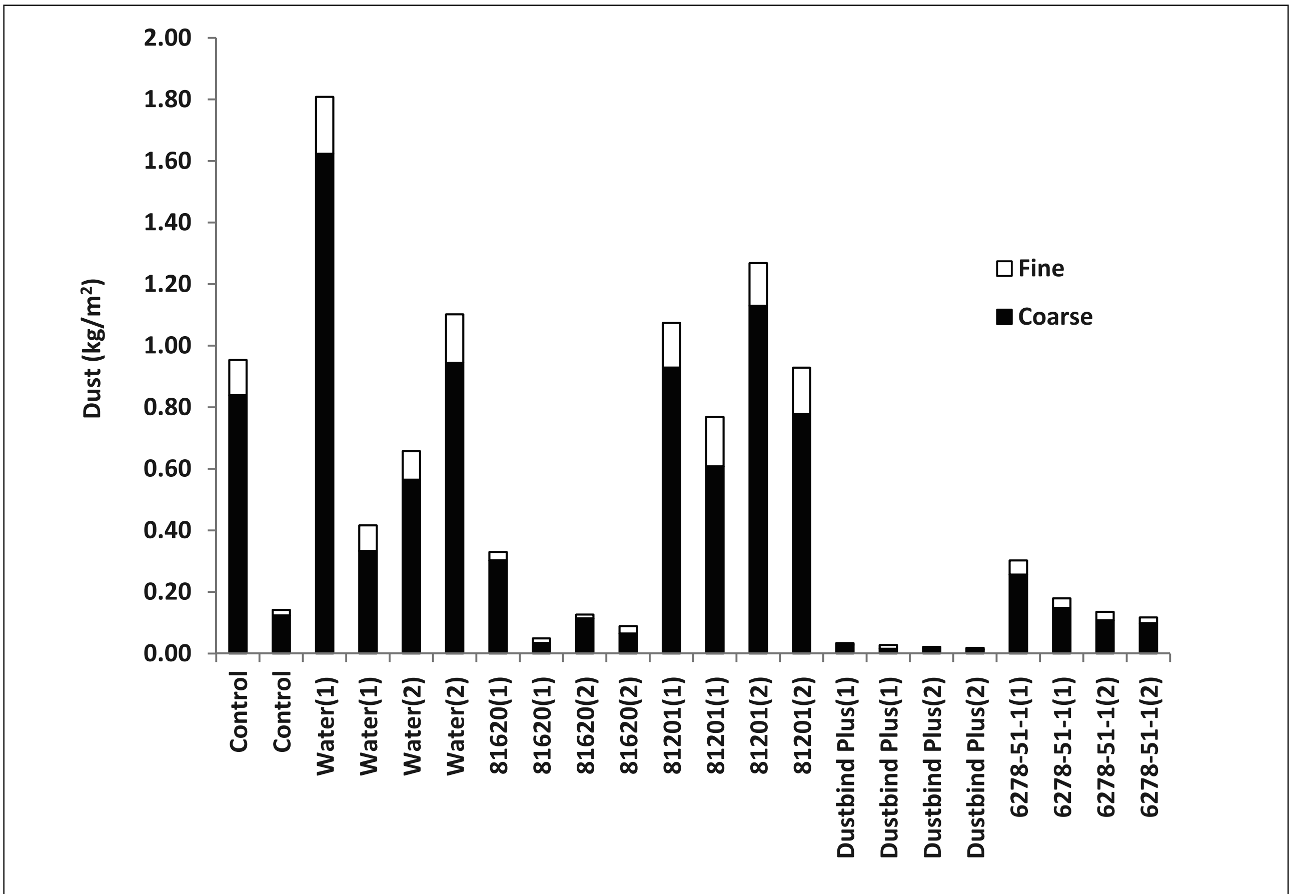

Figure 1: Dust (kg/m^2) formed below the surface crust of surface-treated red mud samples. The number in brackets denotes the weekly application frequency.

The two collection procedures provide an indication of free and trapped dust on and in the first few millimetres of the surface. Free dust should be removed with the first collection and the trapped dust with the second. The coarse and fine dusts were not defined by particle size and data is presented on mass collected from the individual filter chambers of the vacuum cleaner. The different "fractions" are listed to simply give a relative indication of distribution. The amount of dust is reported in kg/m^2 using the mass of dust collected and the collection surface area of each tub (0.0324 m^2 = face area of vacuum attachment).

While the results show substantial variation in a number of the duplicate sample treatments it can be readily seen that treatment with Dustbind Plus significantly reduced the mass of dust formed on the mud surface. Less than 0.04 kg dust per m^2 was collected after both weekly and twice weekly application with excellent replication in this case. In comparison, dust from untreated mud was collected at 0.95 kg/m^2 and 0.14 kg/m^2. Application of water alone proved detrimental resulting in dust being collected in the range 0.42 - 1.8 kg/m^2.

Treatment with Nalco 81620 and 6278-51-1 also showed significant dust suppression with twice weekly application (0.13, 0.09 and 0.14, 0.12 kg/m^2 respectively). The results varied for both products' for weekly application but still showed excellent dust suppression compared to water treatment alone.

3.3 Surface Crust

There was wide variation in the level of cracking in the surface crusts during and after completion of the treatment regimes. In order to try and evaluate this variation, the fragments of crust (formed from cracking) were counted and expressed as the number of crust fragments per m^2 using the tub open face area of 0.106 m^2. The relationship between the number of crust fragments and mass of dust formed below the crust is shown in Figure 2. The mud samples treated with Dustbind Plus, 6278-51-1 and 81620 had surface crusts that remained relatively intact with a low number of crust fragments. Accordingly, for these samples the mass of dust generated was also low.

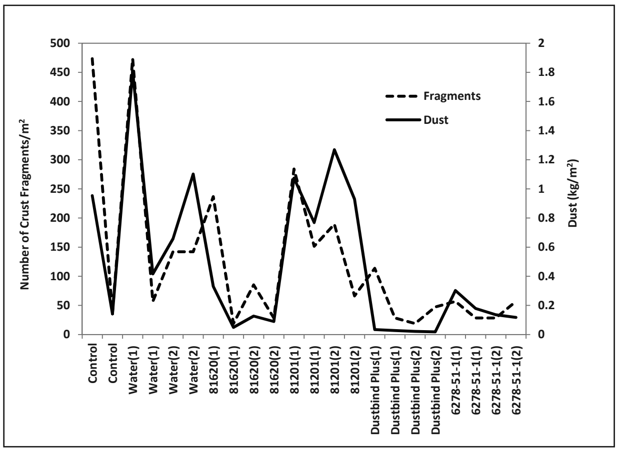

Figure 2: Relationship between surface crust cracking and dust formed.

Similarly the second Water (1) sample, for unknown reasons, had low surface cracking and relative to the first Water (1) sample (heavily cracked surface) the mass of dust generated was quite low. This data suggests that when the crusts remain intact there is a lower amount of dust generated. This is consistent with practical observation in red mud disposal areas with highly cracked areas believed to be the source of most dust.

4. Conclusion

Surface treatment of red mud with a 1 wt-% aqueous solution of Dustbind Plus significantly reduced the mass of dust formed on the mud surface. Less than 0.04 kg dust per m^2 was collected after 10 weeks of a weekly or twice weekly application program. In comparison, dust from untreated mud was collected at 0.95 kg/m^2 and 0.14 kg/m^2. Equivalent treatment with water alone resulted in more than 0.40 kg/m^2 of dust collected – or more than 10 times the amount of the dust compared to samples treated with Dustbind Plus.

From this, the use of Dustbind Plus on dried red mud disposal areas is likely to provide a more effective means of controlling dust than application of water alone. Based on these results it is likely that a solution of Dustbind Plus could be applied at a lower frequency than application of water. This would result in a significant reduction in dust formation as well as providing substantial water savings.

5. Acknowledgements

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